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THE COMING THREE-DIMENSIONAL CIVILIZATION

Mr. Chairman, honored guests, and members of Autonetics Anaheim Management Club: - This is one evening I don't mind spending away from home; I have looked forward to this opportunity to be with you.

Your organization, working within its guideposts of unity, dignity, fellowship, and education, has accomplished much that is good. Your activities have accrued to the benefit of the company as well as your own membership. You have a large place and stake in mankind's future. So I feel a deep sense of honor at being asked to participate in your meeting tonight.

Before addressing my subject "The Coming Three-Dimensional Civilization," I'd like to relate the experience of another speaker whose subject was no less provoking: According to the Times, a gentleman who was to speak to the management club of a large Los Angeles firm was not sure what was expected of him after he happened to see the program

announcement. "In order to properly appreciate the speaker's message," the announcement read, "the officers encourage you to join them beforehand in the cocktail lounge--for an "attitude adjustment" period. (That couldn't have been this Management Club, or this large Los Angeles firm.)

In any case, I hope you didn't forego that part of your program--for your own sake--. It may take a little attitude adjustment on your part to live with the idea that in spite of all our concern over aviation law, the control of the air over our boundaries, the possibility of living 6,000 feet under the seas--we really live in a two-dimensional civilization. All our traffic, our business, our good works, and our wars are oriented to directions that can be plotted on flat maps according to the points of a mariner's compass.

And what I want to talk about is the coming three-dimensional civilization in space.

Just as men now live in communities established on land masses separated by oceans, in the new civilization men will live in communities established on controlled-environment space platforms or spheres separated by space oceans.

The concept of orbiting space stations thoughtfully stocked with creature comforts so that men can live in a shirt-sleeve environment has already made the logical progression in the minds of reasonable men to a concept of "space communities." Architectural units of the communities are envisioned as enormous spheres made of some

new plastic and inflated much like today's experimental inflated houses and furniture. "Activity centers" will be made up of connected structures, and "space scooters" will replace the family car between the centers and residences.

We must recognize that there will be need for much the same services and supplies we demand on earth. Living in space, we may do a lot of things we never did before, but we will continue to do a lot of the old things too: Babies will be born in space. There will evolve generations of space people. Visualize if you can, a space family about to send its oldest son on a trip to Earth to visit the unbelievable home world of his ancestors. There will be some attitude adjustment then, believe me, when they try to explain how any civilization can exist in only two dimensions.

Our life science people have given thought to what may happen to the physical space man. Rapid evolution of man may take place. His habit patterns will have to change; his nervous system will adapt to a new tempo of coordination. Even his physical structure could change; we may see skeletal and muscular alteration, perhaps degeneration, as the physical loads on these systems diminish due to prolonged weightlessness. Man may not need so much sleep, and he will probably live longer, thanks to the reduced physical strains on his bodily systems. Certainly many of man's current ailments, brought on by the infections and contagions of our earth and atmosphere, will disappear in the controlled environment of space living. Think how weightlessness

could help a surgeon, by removing the gravitational pumping loads on the patient's heart, eliminating tissue sag, etc.

There is the story of a little girl in an elevator, who accidentally swallowed her strawberry jawbreaker, and it lodged in her windpipe. The operator's natural reaction was to head for the ground floor at top speed--practically a free fall--and in the brief period of near weightlessness, the candy floated free, and the girl breathed. The examining doctor remarked that there were times in every operation when he wished he could have his patient in that elevator, just to cancel out the pressure of gravity on the vital organs.

In a weightless environment a patient could recuperate faster from a heart attack because his heart wouldn't need to pump so hard to keep the blood circulating. How many of us with pinched-nerve and slipped-disc trouble have wished we could relieve the skeletal compression by simply floating around weightless. These things and much, much more are all part of the long-range planning of the thinkers in the field of aerospace medicine.

In this connection Krafft Ehricke, one of the several world-renowned scientists at North American Rockwell, has visualized a 150-bed hospital, assembled in space, and held in stationary orbit. It would have several wings radiating from a central hub, and they would resemble gigantic, hollow ladders, each rung constituting a specialized ward. Varying

degrees of artificial gravity could be created by varying speeds of rotation of these ladder-rung structures. We have recently had a man's life saved by exposing him to such controlled rotational force to move a bullet from a vulnerable part of his brain to a safe soft tissue resting place!

Krafft has also worked out some detailed proposals for utilizing space for pleasure in the 1990's. He calculated that a space hotel could return a 7% profit charging $80 per day per room. A round trip would cost you $10 per pound, which might be quite an incentive for weight watchers. At the space hotel, you could step from your artificial-gravity room into a complex of zero-gravity rooms for recreation. For example, there would be a large enclosure called a Dynarium in which vacationers would move about in three dimensions, like fish in water, gently floating and tumbling and rolling in circulating air currents, or darting from wall to wall, protected from injury by nets and rubber linings--a kind of three-dimensional trampoline. In another big room there would be three-dimensional tennis--with the net in the form of a spiderweb with a hole in the center, the ball to be batted through the hole from any direction. Outside there might be facilities for space excursion boats or for walks in space suits with tethers.

Our recent Apollo 7 flight has now given us an insight into new physical phenomena in weightlessness. Liquids assume a perfect spherical form--with their surface tension being much more a shaping function than on earth. Bubbles of liquid don't "bounce." Bubbles of air or other gases can be uniformly distributed or suspended inside liquids of all densities. We can probably make sponge-like, lightweight metals of all kinds. Differences in specific gravities will no longer be troublesome in mixing liquids, making uniform alloy metals, etc. We now have a whole new physical factor capability that will enable man to make lighter metals, perfect spherical ball bearings, and many other new and better things for mankind. Truly, we will have "space factories" with capabilities far beyond our comprehension of today.

As the whole new concept of space transportation develops, eventually the most valuable of all functions of a man-made island in space may be as a way station for interplanetary spacecraft. Just as the air age created the need for airports, so will the space age require manned cosmodromes in orbit around the earth. A hydrogen-fueled shuttle ship could rocket up from the earth, dock at the station's hangar, and discharge passengers through a telescoping airlock into a waiting room, while rocket ship service personnel (we could hardly call them "ground

crew") would prepare the vehicle for the return trip. They would swarm about the ship in all posture attitudes, like divers around a submarine, and wearing space suits fitted with a device like North American Rockwell's "EVA" or extra vehicular activity system.

Fantastic? Of course. But a dream? Not anymore.

When Tennyson "... dipped into the future, far as human eye could see," when he "... saw the heavens fill with commerce" and "... the nations' airy navies grappling in the central blue," he was only describing a truly prophetic dream ahead of his time. The scoffers could hardly be blamed; their technology hadn't gone beyond sailing ships.

But we have seen the Apollo!

We know it is our link with tomorrow in space. The Apollo will become our workhorse spacecraft. Before new designs are laid down, Apollo will have been modified, remodified, used, and reused in varying combinations of its component modules with other space equipment.

Speaking of existing and projected hardware, let's look at some of the ideas that have come up: For one, a renovated command module could be reused as an earth-orbiting laboratory. It would be carried aloft, along with its associated equipment, in the "garage" where the lunar landing vehicle is normally carried on Apollo moon missions.

As you know, Apollo was designed to carry three men. A six-man configuration, which would be structurally identical to the three-man version,

could be utilized to transport personnel to and from space stations and bases on the moon. We can also visualize multiple units, joined together in space by a "multiple docking adapter."

A proposed future system concept envisions the use of a spent S-IVB, the third stage of the Saturn booster, as an earth-orbiting workshop. A docking adapter would provide for transfer of material and equipment from the Apollo taxi without depressurization. The docking adapter would have multiple stations to permit attachment of more than one Apollo taxi or to accommodate other equipment such as an astronomical telescope.

Another idea being studied is to place in a low orbit not only the spacecraft and the third stage but the Saturn S-II second stage as well. This could be done by uprating the simplified J-2S engine to 265,000 pounds of thrust. The 38,000-cubic-foot interior of the S-II's liquid hydrogen tank would more than triple the usable volume available in the S-IVB. Various uses are visualized, including equipment and parts storage, shop installations, accommodations for plants and animals employed in scientific experiments, and--conceivably--a centrifuge that could provide artificial gravity and give astronauts some respite from zero-g conditions.

These concepts are not just casual ideas pulled out of the air. As long ago as 1963 our company conducted an independent study of "Self-Deploying Space Station Orbital Support Requirements," and gave it to NASA. It became the basis for a number of requests for proposals.

Apollo is our starting point, but we will ultimately need some other kind of spacecraft in which to shuttle back and forth between the station and the earth. The requirement is for a plane that will take off conventionally and rocket into space. On the return trip, it would enter the atmosphere and land, as our engineers say, "in dignity, without splashing" on land.

So far as our competition goes, there is no doubt that the USSR intends to put space stations into orbit. In 1966 their technical journals indicated that the Soviets had already begun to build components of a permanent orbiting space station that might hold a crew of 30. This possibility is reasonably well supported by what the Soviets have already accomplished.

In 1965 Russia orbited two monster spacecraft called Protons, each as heavy as a Greyhound bus (about 13 tons). Protons would make an excellent first generation space station. Five such vehicles could be assembled in space into a doughnut-shaped cabin ample for the necessary life-support systems, sanitation facilities, and working space for a relatively large Russian crew.

We have the technology now. We have much of the essential hardware; you might say that with multiple Apollo or Gemini spacecraft docked together, we would have an "instant space station." But such projects must wait until funds are available. And when they are available, can the expenditure be justified?

I think it can!

Manned stations in space can serve a variety of purposes. As laboratories, they can make possible the conduct of studies and experiments in virtually all the scientific disciplines--in the space environment. They can make possible an ever-increasing ability to control weather as well as to forecast it, and this implies flood control. As observation posts for studying the earth, they can enable us to improve harvests all over the world, predict their yields, wipe out crop diseases, attack air and water pollution, and locate and inventory mineral and marine resources. One recent example of this was the discovery that a chromium deposit in the south-eastern Egyptian desert was about four times larger than it had been mapped, the evidence being seen in the dark rock complexes discernible in a picture taken from space. Such capabilities alone will ultimately justify all the cost of our space effort.

Plans are on drawing boards for a rocket launching station on the moon, and for various systems to exploit lunar resources. The Surveyor moon probes have detected traces of magnesium, aluminum, nickel, and other minerals on the lunar surface. These may prove useful in construction projects there. Some researchers think the moon can even provide its own water supply, either in the form of water-bearing minerals

or permafrost. Studies indicate we could build a nuclear-fueled power plant on the moon to generate electricity, which could then be used to break water down into oxygen and hydrogen to support life. General Electric estimates than 5,500 gallons of such water would supply enough liquid oxygen or liquid hydrogen fuel to drive a lunar surface vehicle around the moon a dozen times. The cost of producing that much fuel on the moon is expected to be about one million dollars.

Another requirement will be a system for mass transportation to the moon by low-cost nuclear ferries. Such a system is being studied now. Scientists say it could be used over and over again for as many as 50 round trips. With this reusability, the eventual cost of maintaining a moon station is estimated at roughly a million dollars per man per year.

And at that price, it would be a breeze--if only we could eliminate the cost of continuous war.

Over the past years of our nation's space efforts, the Defense Department has avoided duplicating the work of NASA. However, military personnel have monitored or participated in our civilian space program; most of the astronauts, for example, are military officers.

Taken together, NASA and DoD space programs are gradually becoming a single, integrated national program. There are many joint studies including reviews of all findings on earth orbital vehicles, communication satellites, weather satellites, instrumentation networks, control centers and so on.

There are formal agreements to exchange research and technology, and to cooperate on satellite geodesy, gravity gradient tests, and other projects. An agency of our Government, the Aeronautics and Astronautics Coordination Board, coordinates all this work.

We should assume, therefore, that among the early space stations will be some that are joint ventures of NASA and the Defense Department, carrying mixed crews of scientists and military astronauts.

Well, what about the military potential? It's there. We may as well look at it. After all, the same human nature that makes national interest such a driving force on earth turns space objectives into extensions of earth objectives.

As I see it, the military potential of space relates to three general categories: (1) information handling, (2) firepower effectiveness, and (3) flexibility in application of weapon system characteristics.

The advantages that space offers in the areas of global information retrieval and transmission are being exploited logically by the communication utilities; its ability to improve military command control is obvious.

This advantage leads to another: firepower effectiveness. Improved command control and faster information handling mean better timing and accuracy--in short, greater weapon effectiveness.

And the third point is flexibility in application of weapon system characteristics, and this calls for a set of advanced energy-conversion

systems that complement each other. The extensive use of nuclear power is implicit here, and it is significant to note that the application of nuclear fusion to mobile systems is simpler in space than on earth.

New "energy projection" weapons will evolve, with high maneuverability and with completely new destruction characteristics.

Also, it may be almost an understatement to say that the balance of world power will be profoundly influenced by the use of nuclear and/or thermonuclear power in space just as it was in times past by the use of global sea power.

A nation having three-dimensional civilization, being a superpower on earth and having mobility in space, would have more far-flung interests, would have a passion to defend these interests and the military capability to do so, and would have the potential depth to absorb the shock of a global nuclear conflict. It is in this sense that "staying power" in space will emerge as a decisive factor in prevailing on this planet.

Conversely, the stabilizing effect on world peace of a responsible power having this kind of staying power can hardly be overestimated.

We're speaking of the technological prospects for civilization, rather than its destruction, so let's drop the weapons talk.

The peaceful objectives of interspace power transmission may cover a wide variety of tasks, including periodically recharging the battery tanks of unmanned spacecraft by laser beam transmission, thereby eliminating

the easily detectable and damageable solar arrays; supplying continuous power to unmanned primary spacecraft; and eventually even powering secondary spacecraft, (giving them maneuverability without a significant onboard power source). Pointing such laser power beams accurately is obviously a problem, but not an insurmountable one.

Meanwhile, photoreconnaissance vehicles have already been sent to Mars and Venus by both the U. S. and USSR. Next year NASA plans to launch two more. But the improvement since the 1965 Mars probe is almost unbelievable; the new spacecraft will transmit photographs to Earth in 60 seconds, as compared with 8 hours. They will reveal surface features as small as 100 feet, as compared with the mile-wide features of the 1965 pictures. Newly developed advanced film emulsions will provide photos of much higher resolution.

In 1971, if funding is available, two more Mariners similar to the 1969 spacecraft will be launched into an orbit around Mars to send back steady streams of pictures and data. Scientists consider such continuous observation essential because Mars, unlike the moon, shows significant changes on its surface during the long Martian year of 687 days.

The next step, planned for 1973, will be Project Viking, which will send unmanned spacecraft to Mars in an orbiter/lander configuration aboard a Titan III-D/Centaur rocket. Two missions are planned and will be launched 10 days apart. Near the planet, the spacecraft will separate

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into a soft-landing capsule, not unlike a Surveyor, and an orbiter spacecraft of the Mariner Mars 1971 type. While descending, these automated capsules will make direct measurements of Mars' atmosphere. Once on the surface, the lander uses television cameras to scan the landscape, and will activate some really strange instruments to test their surroundings.

One such instrument that could be used is an automatic device called Gulliver, which can shoot out lengths of sticky cord and reel them back in to be dipped into a nutrient broth, tagged with radioactive carbon. If the cord has picked up any Martian organisms, they should grow on the nutrient and give off radioactive carbon dioxide detectable by a Geiger tube. The whole story will be telemetered back to earth.

Another device, called Diogenes, would carry two materials, luciferin and luciferase, the source of light in fireflies, which would glow with a detectable light if they encountered any adenosine triphosphate, the universal energy-releasing compound found in terrestrial life.

Still another device is the Multivator, invented by the Nobel Prize winner Joshua Lederberg. It would vacuum up Martian dust into chambers containing various substances to determine whether there are any Martian enzymes to activate certain basic biochemical reactions known on earth.

Also proposed are automatic, miniaturized mass spectrometers to analyze rocks or soil for chemical constituents.

The next step would logically be manned flyby missions around Mars and back to Earth. Several years ago NASA awarded our company a study contract to investigate the best methods and hardware for performing manned Mars and Venus flybys, making maximum use of existing Apollo/Saturn systems. Our studies supported the feasibility of such a 700-day mission in the late 1970's. It would take four or five Saturn V rockets to lift the equipment needed into earth orbit, there to be assembled into a space-staging base for the Mars operation. The concept called for an uprated Saturn booster to fire a modified second stage of the Saturn V into orbit with its load of hydrogen fuel. There the stage would rendezvous and dock with a waiting spacecraft. Then liquid oxygen tankers, also waiting in orbit, would transfer their oxygen to the hydrogen-powered stage, which would launch the spacecraft toward Mars or Venus.

And what about a manned landing on Mars? This involves a mission of an entirely different magnitude from any previously contemplated. Obviously, aerospace engineers think it can be done. In fact, NASA's Advanced Manned Missions group has been planning such a voyage since 1962, through many small preliminary studies.

The NASA group estimates that a Mars expedition will become a possibility by the early 1980's. The spacecraft for this mission would be capable of sustaining a crew of 9 to 12 men for as long as three years.

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It would be designed and equipped to make detailed scientific observations in interplanetary space and in orbit around a planet. This means a much bigger payload, which in turn, demands a much more powerful booster than anything now available.

But we are making fantastic advances in propulsion. With a new aerospike rocket engine being developed, we expect to quadruple the lifting power of the Saturn V. A nuclear-powered upper stage is scheduled for testing in the 1970's. So the Saturn could send men to Mars.

Looking further ahead, NASA laboratories are already exploring various systems for nonchemical propulsion. Plasma power promises eventually to play an important role. The form of matter that physicists call plasma consists of electrically charged particles that push and tug at one another while darting about at furious speed. The energy inherent in this speed makes most plasmas far hotter than any known chemical flame. Because they are so much hotter and can be accelerated by electromagnetic fields, plasmas can deliver far more energy per pound than chemical fuels.

Several kinds of plasma engines have been built and tested, but it is unlikely that any will be made big enough to lift a space vehicle off the earth. The plasma engine will take over in space and accelerate the vehicle gently but steadily for weeks or months, maybe eventually at close to the speed of light.

In the study of electric propulsion, NASA has estimated the weight saving over chemical propulsion for an eight-man expedition to Mars. Both electric and chemical systems would start with a huge space ship, up to 600 feet long, assembled in orbit with a payload of 100 tons. The chemical space ship would have to weigh 1,200 tons in all; the electric ship would weigh only one-sixth as much.

However, long leadtimes are needed to put together these vast projects, and planning must be done years in advance. As space programs become bigger and more complex, a 6- to 10-year leadtime seems inevitable.

But you can be sure that the men who have one eye on the moon have the other fixed well beyond it, on the rest of the solar system.

Not since Galileo poked the first "optik tube" at the sky in 1609 has there been such an opening of windows on the universe as there has been in this first decade of space exploration.

Rockets in deep space have sent back tantalizing hints that there may be new forms of matter to be discovered. Today we know beyond doubt that space is filled with interacting forces and energies. In one constellation of our own galaxy is a huge source of x-rays, undetectable from earth, but about 1,000 times more intense than those from the sun. And in the distant galaxies, we have detected other inexplicably enormous sources of energy, many times greater than any thermonuclear processes known on earth. Astronomers have detected radio emissions from five

remote objects that literally defy description. Known only as quasi-stellar radio sources, or quasars for short, they are neither stars nor galaxies. They are one hundred times brighter than our whole galaxy.

All this leads physicists to expect the discovery of entirely new principles for generating tremendous power and for transmitting and converting it. Consequently, our program of space probes has moved from small satellites fitted for a single mission into a new generation of big, advanced, flying-boxcar projectiles crammed with instruments for broad-scale attacks on big areas of intergalactic space.

Ultraviolet, gamma ray, and x-ray instruments may well reveal entirely new and perhaps revolutionary aspects of the universe. Experiments planned for advanced satellites and for a lunar base include investigations of huge clouds of hydrogen floating between stars, runaway galaxies, galaxies in collision, exploding stars--and even the force of gravity.

For more than 10 years the world has been getting used to the idea that men are going to explore the universe. The prophecies of the early pioneers of astronautics have come true so many times, since the first rockets climbed into space, that few people disbelieve the prophets now. For all the spectacular advances made in the first decade of the Space Age, the frontiers have barely been breached. But soon man will look at earth for the first time with his feet planted on the surface of another celestial body.

The power to reach the planets is almost within our grasp. Just as the mariners of the 15th century started an unstoppable process of exploration, the spacemen of the 20th and 21st centuries will go on and on. Man stands on the brink of space, preparing for the greatest adventure in all of his history.

To cope with the problems of a three-dimensional civilization, man must become three dimensional in his thinking and understanding. We need "big" men who can bury the day's petty problems in favor of gaining a whole new universe for man tomorrow.

You and I are part of the mechanism to bring this all about. Let's be sure we rise to the task--for our company--our country--and all mankind.

Thank you.